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Higher mortality rates amongst emergency patients admitted to hospital at weekends reflect a lower probability of admission

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Abstract

Objective: Patients admitted as emergencies to hospitals at the weekend have higher death rates than patients admitted on weekdays. This may be because the restricted service availability at weekends leads to selection of patients with greater average severity of illness. We examined volumes and rates of hospital admissions and deaths across the week for patients presenting to emergency services through two routes: (a) hospital Accident and Emergency departments, which are open throughout the week; and (b) services in the community, for which availability is more restricted at weekends.

Method: Retrospective observational study of all 140 non-specialist acute hospital Trusts in England analyzing 12,670,788 Accident and Emergency attendances and 4,656,586 emergency admissions (940,859 direct admissions from primary care and 3,715,727 admissions through Accident and Emergency) between April 2013 and February 2014.Emergency attendances and admissions to hospital and deaths in any hospital within 30 days of attendance or admission were compared for weekdays and weekends.

Results: Similar numbers of patients attended Accident and Emergency on weekends and weekdays. There were similar numbers of deaths amongst patients attending Accident and Emergency on weekend days compared with weekdays (378.0 vs. 388.3). Attending Accident and Emergency at the weekend was not associated with a significantly higher probability of death (risk-adjusted OR: 1.010).

Proportionately fewer patients who attended Accident and Emergency at weekend were admitted to hospital (27.5% vs. 30.0%) and it is only amongst the subset of patients attending Accident and Emergency who were selected for admission to hospital that the probability of dying was significantly higher at the weekend (risk-adjusted OR: 1.054).

The average volume of direct admissions from services in the community was 61% lower on weekend days compared to weekdays (1317 vs. 3404). There were fewer deaths following direct admission on weekend days than weekdays (35.9 vs. 80.8). The mortality rate was significantly higher at weekends amongst direct admissions (risk-adjusted OR: 1.212) due to the proportionately greater reduction in admissions relative to deaths.

Conclusions: There are fewer deaths following hospital admission at weekends. Higher mortality rates at weekends are found only amongst the subset of patients who are admitted. The reduced availability of primary care services and the higher Accident and Emergency admission threshold at weekends mean fewer and sicker patients are admitted at weekends than during the week. Extending services in hospitals and in the community at weekends may increase the number of emergency admissions and therefore lower mortality, but may not reduce the absolute number of deaths.

Keywords

emergency care, mortality, weekend effect

Introduction

The finding that patients admitted to hospital in an emergency at the weekend have a higher mortality rate than those admitted during the week is well documented.[1–6] However, the cause of this 'weekend effect' is not known.

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The phenomenon has been attributed to reduced availability of senior clinical staff and reduced access to investigative services in hospitals at weekends,[3,4,7] but there is no causal evidence establishing this link.[8–12] Nevertheless, the existing evidence has been used to support moves by the NHS in England towards 7-day working.[3,13]

This leap from the detection of a statistical association to a reorganization of the way in which the NHS is provided and staffed has come under unprecedented criticism.[8,10,11,14,15] Numerous commentaries have raised serious concerns over the interpretation of the papers that have been used to underpin these service changes, highlighting various alternative explanations for the finding of increased mortality rates amongst those admitted to hospital at weekends.

A major concern is that differences in the severity of patients admitted to hospital at the weekend compared to during the week may not be captured fully by the case-mix variables available in administrative datasets.[10,11,15] The number of patients admitted to hospital in an emergency on weekend days is markedly reduced at weekends.[1,6,8] This may be because the population is less likely to seek emergency care, Accident and Emergency (A&E) departments are less likely to admit patients and/or the limited availability of services in the community at weekends leads to fewer direct admissions to hospital. Higher death rates among the smaller number of patients who are admitted at weekends might partly reflect a higher average severity of illness amongst those who are admitted rather than excess avoidable deaths caused by poorer quality of care on admission.

Better understanding of how patients end up in hospital on different days is required if we are to determine whether the weekend effect is a matter for policy concern or a statistical artefact.[15] Our aim is to investigate whether the weekend effect in mortality amongst admitted patients reflects admission of fewer or sicker patients who are at greater risk of dying. We analyse the variation by day of the week in the volume of admissions and subsequent mortality, stratifying patients by their route of access to hospital. We exploit previously under-utilized data on A&E attendances to investigate whether higher mortality amongst the population of patients admitted to hospital reflects a more stringent admission threshold. We then examine the extent to which the limited availability of services in the community at weekends leads to fewer direct admissions and whether there is a higher mortality rate amongst the restricted number of patients who are admitted via this route.

Methods

Data source

We used individual patient-level data on 12,670,788 A&E attendances and 4,656,586 emergency admissions from Hospital Episode Statistics between 1 April 2013 and 28 February 2014.[16] We used a 11-month study period as data were available for 1 April 2013 to 31 March 2014 and each patient was followed for 30 days after attendance or admission to analyse mortality within this subsequent period. We focused on attendances at Type 1 units, which are consultant-led, multi-specialty 24-hour services with full resuscitation facilities and designated accommodation for the reception of A&E patients. These units exclude single specialty centres, minor injury units and walk-in centres, and account for 99% of emergency admissions via A&E.[17]

The attendance records contain information on the patient's age, sex, ethnic group, diagnosis, arrival by ambulance or other mode, whether the attendance is a first or follow-up visit, where the incident occurred (home, work, educational establishment or other public place), the type of accident (including road traffic accident, assault, deliberate self-harm, sports injury), whether the attendance was patient-initiated or recommended by a professional in another organization, the date of attendance and whether the patient was admitted, discharged or died in the A&E department.

The admission records contain information on the patient's age, sex, ethnic group, primary and secondary diagnoses classified using ICD-10, whether the patient was admitted from home or another institution, the date of admission, and whether the patient was admitted via A&E or directly by a GP, through a bed bureau, or by a consultant in a scheduled ambulatory clinic. Each record also contains the date of death if the patient died in hospital.

We analysed attendance and admission records from all 140 non-specialist acute Trusts in England. We linked these records using an encrypted patient identifier to the dates of death of all patients who had died in any hospital in England between 1 April 2013 and 31 March 2014. We focused on deaths within 30 days of attendance or admission.

To control for deprivation, we attached the Index of Multiple Deprivation 2010 score to the attendance and admission records using the patient's lower-layer super output area (LSOA) of residence.[18] England is divided into 32,844 LSOAs, with a mean population of 1500.[19,20] We included all records for patients whose area of residence in England was known, excluding 772 A&E attendances (0.006% of records) for which risk-adjustment variables were missing.

Statistical analysis

Throughout our analysis we separate patients by their route of admission to hospital, examining two distinct groups. The first group we examine are patients who access emergency services through A&E, which make

up the majority of emergency admissions.[17,21] This includes patients directed by their GP to attend. To examine the importance of selection effects amongst the admitted population due to variations in clinical decisions to admit, we focus initially on the entire population of patients who attend A&E and then restrict the analysis to the subset who are selected for admission.

The second group consists of patients admitted directly to hospital in an emergency (circumventing the A&E department) by GPs, through a bed bureau or by specialists in ambulatory clinics, termed 'direct admissions' (HES admission method codes 22, 23 and 24). The availability of these community services is more limited at the weekends compared to during the week and we examine whether this leads to fewer direct admissions and whether there is a higher mortality rate amongst the restricted number of patients who are admitted via this route.

Within these groups we compared the mean numbers of A&E attendances, emergency admissions and deaths per day between each day of the week and between weekdays and weekend days using *t*-tests.

We used logistic regression to estimate the risk-adjusted probability of dying within 30 days for the entire population of patients attending A&E departments by day of the week. We then estimated the risk-adjusted probability of being admitted to hospital and the risk-adjusted probability of dying for the subset of patients who are selected for admission. The case-mix adjustment in these models included information taken from the A&E attendance records on age, sex, ethnicity, diagnosis, arrival mode, first or follow-up visit, incident location, accident type, referral source, deprivation quintile, month and hospital attended.

We also used logistic regression to estimate the risk-adjusted probability of dying within 30 days of direct admission by day of the week. The case-mix adjustment in these models included information taken from the admission records on age, sex, ethnicity, primary diagnosis (SHMI-grouped Clinical Classifications Software category), Elixhauser (comorbidity) conditions, admission method, admission source, deprivation quintile, month and admitting hospital.[22–24] SHMI-grouped Clinical Classifications Software is a tool for grouping patients into a manageable number of clinically meaningful categories using ICD-10 diagnosis codes.[25,26]

We compared each day to Wednesday and then estimated another model comparing weekend admissions to weekday admissions.

The analysis was undertaken using Stata version 13. We clustered the error terms to account for the multiple observations of some individuals using the Stata command 'robust cluster(id)' and summarized the goodness-of-fit of the models using the C-statistic.

Results

A&E department attendances

The average number of people attending A&E is highest on Monday and lowest on Friday (Table 1). Average numbers of attendances on weekend days are similar to weekdays.

The characteristics of patients attending A&E on weekdays and weekends are given in online Appendix 1. A slightly higher proportion of patients attending A&E at the weekend are children or younger adults, but similar proportions are in the oldest age groups (90+) on weekend days and weekdays. Proportions of patients with the most common presentations are similar on weekends and weekdays.

The average number of patients attending A&E on weekend days and dying within 30 days is similar to weekdays (Table 1). The crude death rate following an A&E attendance is significantly lower at the weekend compared to during the week (0.99% vs. 1.03%).

The risk adjustment model was strongly predictive of mortality (C-statistic of 0.92). After adjusting for risk, attending A&E at the weekend is not associated with a significantly higher probability of mortality than attending during the week (Table 1). Examining the results for each day separately, attending A&E is associated with small but statistically significant higher probabilities of mortality for Sundays and Mondays compared to Wednesday attendance. These increases in relative risk equate to absolute increases in the risk of death of 0.034 percentage points on Monday and 0.037 percentage points on Sunday, from a baseline of 1.02% on a Wednesday.

Admissions via A&E departments

Results for the population of emergency patients who are admitted to hospital when they attend A&E are given in Table 2. The proportion of the patient population attending A&E at the weekend admitted to hospital compared to those attending during the week is 2.6 percentage points lower. Consequently, average numbers of admissions via A&E are 7% lower for weekend days than for weekdays.

The risk adjustment model for the probability of admission had a C-statistic of 0.83. The adjusted admission rate of patients attending A&E at the weekend remains significantly lower compared to those attending during the week (OR: 0.946).

The risk adjustment model for the probability of mortality amongst the subset of patients who are admitted when attending A&E had a C-statistic of 0.91. Patients admitted at the weekend have a significantly higher probability of mortality compared to those admitted during the week (OR: 1.054; CI: 1.040–1.069). These results are similar regardless of whether risk-adjustment

Table 1. Accident and Emergency (A&E) department attendances and mortality within 30 days.

	Average volume of A&E attendances per day on this day of the week	Average number of deaths within 30 days following A&E attendance per day on this day of the week	Crude mortality rate within 30 days following A&E attendance on this day of the week	Risk-adjusted mortality rate within 30 days following A&E attendance on this day of the week[a]
				Odds ratio
Monday	41,416.8	402.9	0.97%	1.034 [1.014, 1.055]
Tuesday	37,470.6	388.1	1.04%	0.994 [0.974, 1.014]
Wednesday	36,932.9	375.6	1.02%	Reference
Thursday	36,815.2	385.6	1.05%	1.010 [0.989, 1.030]
Friday	36,425.6	389.4	1.07%	0.996 [0.976, 1.016]
Saturday	37,165.9	374.9	1.01%	0.997 [0.976, 1.017]
Sunday	39,341.8	381.1	0.97%	1.037 [1.016, 1.058]
Weekday	37,812.2	388.3	1.03%	Reference
Weekend	38,253.8	378.0	0.99%	1.010 [0.997, 1.022]
Difference (Weekend–Weekday)	441.6 [−147.5, 1030.8]	−10.3 [−22.3, 1.8]	−0.04% [−0.076%, −0.001%]	
Ratio (Weekend:Weekday)	1.01	0.97	0.96	

[a]Logistic regression models including controls for age, sex, ethnicity, diagnosis, arrival mode, first or follow-up visit, incident location, accident type, referral source, deprivation quintile, month and hospital attended.

variables are taken from the A&E or inpatient records. Examining the results for each day separately, admissions on Sundays, Saturdays and Mondays are associated with higher mortality compared to Wednesday admissions. These are the days on which the patients who attend A&E have the lowest risk-adjusted probabilities of admission.

Direct admissions

The average number of direct admissions to hospital from services in the community is fairly stable across weekdays, but is 61% lower at weekends (Table 3). The characteristics of patients directly admitted to hospital on weekdays and weekends are given in online Appendix 2. A higher proportion of patients directly admitted at the weekend are children, younger adults or very elderly (0–34 years or 90 and over) compared to weekdays. The most common primary diagnoses amongst patients directly admitted during the week are abdominal pain, influenza and headaches. For those directly admitted during the weekend, these are influenza, abdominal pain and intestinal infections. The population directly admitted at the weekend is less likely to have most of the Elixhauser comorbidities reported.

The average number of patients directly admitted on weekend days and dying within 30 days is significantly lower than for weekdays (36 vs. 81) (Table 3). However, due to the proportionally larger reduction in the average number of direct admissions at the weekend, the proportion of admissions that lead to death within 30 days is higher at weekends than weekdays (2.72% vs. 2.37%).

The model used to predict the probability of mortality produced a C statistic of 0.92. Adjusted mortality rates for directly admitted patients are lowest for Friday admissions (OR: 0.968) and highest for those admitted on Sunday (OR: 1.278). Compared with direct admissions on a weekday, the relative risk of mortality within 30 days was 21.2% higher for direct admissions at the weekend. This equates to a 0.488 percentage point increase in the risk of death, from a baseline of 2.37% during the week.

Discussion

Main findings

Patients admitted to hospital as emergencies at the weekend are known to have a higher rate of death than patients admitted during the week. However, we did not find higher mortality for the whole population attending A&E departments at weekends. The weekend effect was only apparent in the subset of patients who are admitted to hospital, and was far stronger for patients directly admitted from the community – who were admitted in far smaller numbers at weekends – than for patients admitted via A&E. These findings

Table 2. Admissions via accident and Emergency (A&E) departments and mortality within 30 days.

	Average volume of admissions via A&E per day on this day of the week	Crude admission rate on this day of the week	Risk-adjusted admission rate on this day of the week	Crude mortality rate within 30 days following admission via A&E on this day of the week	Risk-adjusted mortality rate within 30 days following admission via A&E on this day of the week (A&E records)[a]	Risk-adjusted mortality rate within 30 days following admission via A&E on this day of the week (APC records)[b]
			Odds ratio		Odds ratio	Odds ratio
Monday	11,644.8	28.1%	0.979 [0.974, 0.984]	3.46%	1.032 [1.011, 1.053]	1.036 [1.012, 1.060]
Tuesday	11,401.0	30.4%	0.990 [0.985, 0.996]	3.40%	0.997 [0.977, 1.018]	1.000 [0.977, 1.023]
Wednesday	11,153.2	30.2%	Reference	3.37%	Reference	Reference
Thursday	11,241.3	30.5%	1.009 [1.004, 1.015]	3.43%	1.008 [0.987, 1.029]	1.019 [0.995, 1.042]
Friday	11,357.5	31.2%	1.010 [1.005, 1.016]	3.43%	0.981 [0.961, 1.001]	1.009 [0.986, 1.033]
Saturday	10,557.7	28.4%	0.945 [0.940, 0.951]	3.55%	1.037 [1.016, 1.059]	1.047 [1.023, 1.072]
Sunday	10,494.2	26.7%	0.943 [0.937, 0.948]	3.63%	1.081 [1.059, 1.104]	1.088 [1.063, 1.114]
Weekday	11,359.6	30.0%	Reference	3.42%	Reference	Reference
Weekend	10,525.9	27.5%	0.946 [0.943, 0.950]	3.59%	1.055 [1.042, 1.068]	1.054 [1.040, 1.069]
Difference (Weekend–Weekday)	−833.6 [−940.6, −726.7]	−2.6% [−3.0%, −2.1%]		0.17% [0.08%, 0.27%]		
Ratio (Weekend:Weekday)	0.93	0.92		1.05		

[a]Logistic regression models including controls for age, sex, ethnicity, diagnosis, first or follow-up visit, incident location, accident type, deprivation quintile, month and hospital attended.
[b]Logistic regression models including controls for age, sex, ethnicity, primary diagnosis (SHMI-grouped Clinical Classifications Software category), Elixhauser conditions, admission method, admission source, deprivation quintile, month and admitting hospital.

Table 3. Direct emergency admissions and mortality within 30 days.

	Average volume of admissions per day on this day of the week	Average number of deaths within 30 days of admission per day on this day of the week	Crude mortality rate within 30 days following admission on this day of the week	Risk-adjusted mortality within 30 days following admission on this day of the week[a]
				Odds ratio
Monday	3489.2	83.7	2.40%	1.032 [0.982, 1.085]
Tuesday	3351.4	79.7	2.38%	1.018 [0.968, 1.071]
Wednesday	3232.9	76.5	2.37%	Reference
Thursday	3336.1	78.2	2.34%	0.984 [0.935, 1.035]
Friday	3611.7	85.8	2.38%	0.968 [0.922, 1.018]
Saturday	1397.5	36.7	2.63%	1.154 [1.082, 1.231]
Sunday	1237.3	35.0	2.83%	1.278 [1.196, 1.366]
Weekday	3404.3	80.8	2.37%	Reference
Weekend	1317.4	35.9	2.72%	1.212 [1.162, 1.263]
Difference (Weekend–Weekday)	−2086.9 [−2174.4, −1999.4]	−44.9 [−47.8, −42.0]	0.35% [0.24%, 0.46%]	
Ratio (Weekend:Weekday)	0.39	0.44	1.15	

[a]Logistic regression models including controls for age, sex, ethnicity, primary diagnosis (SHMI-grouped Clinical Classifications Software category), Elixhauser conditions, admission method, admission source, deprivation quintile, month and admitting hospital.

suggest a sicker population of patients is admitted to hospital at weekends and that this selection effect is partly responsible for the weekend effect.

Higher mortality rates amongst the population of patients admitted to hospital in an emergency at weekends is driven by a reduction in the volumes of patients admitted to hospital at the weekend rather than an increase in the number of deaths. There were 7% fewer admissions through A&E at weekends, which was not explained by the patient characteristics that we could control for. Hospital staff appear to apply a more stringent admission threshold at weekends to patients seeking emergency care in A&E. This raises the possibility that the patient population admitted at weekends is on average sicker than the population admitted on weekdays, and that this difference is not completely captured by standard risk adjustment using administrative data.

The weekend effect is greatest amongst the patients directly admitted to hospital, for whom the relative risk of mortality was 21% higher at the weekend. However, the number of admissions through this route was 61% lower at weekends compared to weekdays and these admissions represent just 11% (1317/(1317 + 10526)) of total emergency admissions on a typical weekend day. The lower volume of direct admissions at weekends is not matched by higher A&E attendances or admissions, indicating that patients are not simply being switched between the two routes into hospital at weekends. The concentration of the weekend effect where we see a substantial restriction in the patient flows again raises the possibility that it is due to inadequate measurement of how sick they are rather than lower quality of care at admission.

There may be concern that patients who are directly admitted could experience different quality of care on arrival at hospital. A small proportion (6%) of patients attending A&E are known to have been referred there by a GP, and they are therefore part of the same patient pool as direct admissions in that they initially sought GP care. However, upon arrival at A&E these patients would be expected to receive the same care as those who self-refer to A&E. In an attempt to shed further light on our findings we performed some supplementary analysis on this group of patients. We found that the flows of patients referred to A&E by a GP behaved in much the same way as the direct admissions. The volume of A&E attenders referred by a GP dropped by 68% at weekends, as did the volume of admissions through A&E for this patient group. Attending A&E on a weekend following GP referral was associated with a significantly higher risk-adjusted probability of mortality (OR: 1.168; CI: 1.096–1.245). These findings suggest that direct admission to hospital at the weekend is not a cause of elevated mortality, but instead an indicator of an inherently different patient group. If the cause of elevated weekend mortality amongst direct admissions was lower quality of care upon admission

rather than referral of sicker patients, we would not expect to see a weekend effect amongst patients referred to A&E by a GP.

Strengths and limitations

This study used data covering the complete population of patients attending consultant-led A&E departments and all emergency admissions to non-specialist acute hospitals in England over a 11-month period. Our risk adjustment models for mortality had high explanatory power (C-statistics equal to 0.92), but in common with previous studies we could not take severity of the primary diagnosis into account, thus limiting our ability to risk adjust.[27] We also did not have information on out-of-hospital deaths and therefore could only include deaths that occurred in any hospital within 30 days of admission. This would generate bias if the proportion of all deaths that occur in a hospital is different for weekend admission.

For an earlier year (1 April 2010 to 31 March 2011), we do have data on out-of-hospital deaths and these show that a slightly higher proportion of all deaths within 30 days of admission occurred in a hospital for weekend admissions (81.3% vs. 80.1%). Our ability to only include in-hospital deaths in the more recent data is therefore likely to have a larger effect in reducing the weekday death rate than the reduction in the weekend death rate. If the weekend and weekday death rates were the same, we would find weekend death rates that were 1.5% higher (81.3%/80.1%) using only in-hospital deaths. Our analysis is therefore likely to contain a small bias towards finding higher death rates at the weekend.

Comparison with previous studies

Previous studies have compared mortality risk, adjusted for patient characteristics, between those admitted to hospital during the week and their counterparts admitted on weekends.[1,2,4,6,9] These studies have consistently found higher mortality rates for patients admitted at weekends, both before and after risk adjustment. Whilst we have also found higher mortality rates amongst patients admitted at weekends, our study differs in two important respects. First, we widened our focus to include all patients attending A&E departments, including those not admitted, in order to avoid possible selection effects in the admitted population. Second, we assessed direct admissions and admissions via A&E separately, in order to gain a better understanding of variations in patient flows throughout the week. Using this approach we found there were fewer patients admitted to hospital in an emergency on weekends, attributable to a 61% lower volume of direct admission and a 5% lower risk-adjusted probability of admission following an A&E attendance. These increased thresholds for admission at weekends are likely to have biased previous studies on weekend mortality.

Policy implications

Current initiatives to move towards seven day hospital services are only likely to be successful in reducing mortality if reduced availability of services in hospitals on the day of admission is the major cause of the weekend effect. Our findings cast significant doubt over whether this is the case. Patients who attend A&E on weekends are at no higher mortality risk than patients who attend A&E on weekdays. However, a smaller proportion of attending patients are admitted at the weekend and this higher threshold for admission is likely to mean that patients who are admitted via A&E at the weekend are, on average, sicker than patients admitted during the week. Reduced availability of primary care services at weekends means that fewer patients are admitted to hospital via this route and these patients are also likely to be sicker than their counterparts admitted during the week.

Our results add to the increasing body of evidence questioning the use of standardized mortality rates as an indicator of the quality of care in hospitals.[28–30] The weekend effect identified in previous studies may be a statistical artefact driven by the selection bias introduced by restricting the focus to the admitted population. Extending services in hospitals and in the community at weekends may increase the number of emergency admissions, particularly for patients with less severe illness, and this could have the desired effect of achieving lower hospital mortality rates. However, this would be a statistical phenomenon rather than a clinically meaningful improvement as it would be achieved by admitting less sick patients rather than by reducing the absolute number of deaths.

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